JOURNAL OF ENGINEERING AND TECHNOLOGY, Vol. 7 No. 2 December 2009 ISSN 1684-4114
http://www.iutoic-dhaka.edu/jet

A Study of Performance of a Box-type Solar Cooker with and without Booster Reflectors

A. K. M. Iqbal Hussain*

Received 10 June 2009; Accepted after revision 12 December 2009

ABSTRACT

Every year millions of tones of biomass and fossil fuels are burnt to cook foods around the world. As reserves of these fuels are limited, attention must be given to utilize solar energy for cooking purposes. Although concentrating solar cookers can produce high temperatures, its usage is restricted because of high costs and complexity in handling. On the other hand, box-type solar cookers using conventional flat-plate collectors are relatively cheap and easier in handling. In this research work, a box-type cooker was constructed and experiments were carried out in the IUT Campus during the month of April when the sky remains fairly clear. Modifications of the simple cooker are done by adding plane booster reflectors on three sides of the cooker box. Experiments are carried out with both the simple and the modified types over several days from 10:00 a.m. to 4:00 p.m. Relevant data e.g. half-hourly and cumulative available solar radiation intensity, temperature of two glass cover plates, temperatures of heated water, ambient air temperature and its average speed are recorded every hour. From the experimental data, performance parameters, such as heat loss coefficients, useful heat rates and the cooker collector efficiencies at different absorber plate temperatures at different hours of the day are computed using relevant equations and have been presented in graphical forms. Results show that the cooker with booster reflectors can heat

** Department of Mechanical and Chemical Engineering, Islamic University of Technology (IUT), Bangladesh. Email: iqbal@iut-dhaka.edu*

water to about 93^{0}C which is close to normal cooking temperature of 100^{0}C for added water in foods whereas, the cooker without reflectors can heat the water to about 65^{0}C. Hence, even preheating of the food by the cooker will require a small amount of additional supplementary heat which can be produced by burning biomass or conventional fossil fuel in order to accomplish the cooking process.

Keywords: *Biomass and Fossil Fuels, Solar Energy, Solar Cookers, Booster Reflectors, Flat-plate Collectors, Cooking Temperature.*

1 INTRODUCTION

A solar cooker is a simple device in which solar heat is used for heating, cooking foods etc. As solar energy is abundant and reserve of conventional fuels, both fossil and biomass, are limited, attention must be given to the use of solar energy in cooking. During the past 50-60 years, a variety of solar cookers, using both flat-plate and concentrating solar collectors, have been developed and tested but the cost and complexity of operation have discouraged its usage by the common masses. In concentrating type, high temperature for complete cooking can be achieved but these are expensive and needs continuous tracking of the sun. On the other hand, box-type solar cookers, using flat-plate collectors, cannot normally produce in most locations temperatures above 100^{o}C which is the normal cooking temperature of common foods. Hence, these cookers cannot be used for complete cooking process. But it can be effectively used for preheating (sensible heating) the liquid or food upto certain temperature (about 90^{o}*C*). Then the cooking processes can be completed by using supplementary heat by burning conventional fuels. This will result in saving of the conventional fuel costs. Although a number of well-designed and fairly efficient solar cookers have been constructed and tested their practical use in cooking foods [5], [7], [8], [10], [16] and [22]. But there have many limitations due to

(i) Too expensive for individual family ownership.
(ii) Complexity in use.
(iii) Cooking can be done only when clear sunshine is available.
(iv) Cannot be used indoors.
(v) Incompatible with traditional cooking habits and
(vi) Cannot be used for complete cooking (except the concentrating type) etc.

However, mass education, training, government subsidy and publicity are required to popularize solar cookers.

In this work, a thermal analysis of the conventional box-type solar cooker collector is presented. This is followed by construction and study of performance of the cooker in the location of Gazipur, Bangladesh. Experiments have been carried out for several sunny days in the month of April, by measuring the half hourly available solar radiation intensity on these days. Then modification of the existing cooker is made by adding plane booster reflectors on three sides. The performances of the box-type solar cooker without reflectors and the modified box-type solar cooker with reflectors have been presented and compared.

2 BRIEF REVIEW OF PREVIOUS WORK

Solar cookers are basically solar energy collectors and extensive work has been done on solar energy collectors in the past many years. D. K. Edward et al. [1] and A. Whillier [2] had presented comprehensive data on properties of selective coatings used in flat-plate solar collectors. Their data were recommended for use in designing solar radiation absorbers. A. F. Souka et al [3] had studied, in details, the effect of orientations of the collectors and determined the optimum till angle for best performance. C.L. Gupta et al [4] and S. Kumar et al [21] presented detailed performance result of flat plate collectors including heat loss factors and collector efficiencies. K. Selcuk [5] analyzed the economic aspects also in addition to its thermal performance. T. Fujii et al [6] calculated the heat transfer rates from flat surfaces in natural convection when the plate was inclined at an angle with the horizontal, Data presented from their studies can be satisfactorily used in designing flat-plate collectors and cookers. S. A. Klein et al [7], [15] presented a detailed analysis and experimental data considering transient characteristics of the solar radiation. These data and results are useful for designing solar collectors of different types. S. A. Klein [8], A. Malhotra et al [17] and S.C. Mullick et al [20] presented the heat loss factors from top, sides and bottom of flat plate collectors of various designs operating at different times of the day. They also studied the efficiencies of the collectors at varying operating conditions and correlated the experimental heat transfer data. H. Buchberg et al [19] presented data on natural convection heat transfer in inclined and enclosed spaces between glass covers and glass cover-absorber of the collector. These data were claimed by the authors to be reliable and can be used in collector designs. S. I. Abdel-Khalik [10] presented data on heat loss items and useful heat in collectors. These data can use for heating air or water by collectors. F.F. Simon [11], D.K. Edwards [12], N.E. Wijeysundera [13] and M. Collares-Pereira et al [14] presented extensive experimental data on design and performance of solar collectors including long-term average performances of both concentrating and non-concentrating types. Details studies on direct, diffuse and reflected radiation through collector glazings had been made by M. J. Brandemuehl [16] and useful performance data had been presented. A.K. Saxena et al [18], S. C. Mullick et al [19] and [22] designed, constructed and tested few types of box-type solar cookers, and correlated experimental data in terms of first and second figures of merit. They, however, conceded that further improvement of the cooker performance was necessary to achieve satisfactory temperature levels inside the cooker.

3 HEAT TRANSFER PROCESSES

The principal ways of cooking foods are boiling, frying, roasting and baking. When boiling is the process for cooking foods like rice, lentils, soups etc., the temperature for cooking is approximately 100^oC, whereas for other methods higher temperature are required. Heat is supplied to the food by convection and to some extent by radiation. When a steady temperature of boiling has reached, not much further heat supply is needed. Under this condition, the heating rate should be equal to the thermal heat loses from the vessel plus the heat required for evaporation of water from the food. It should be realized that the largest amount of heat (2,257 *kJ/kg* of water) is required for evaporation of water from the food. Convection heat loss from the walls of the cooking vessel may be quite high and can be reduced by using covers on the cooking vessel and by painting black the outer surface of the cooker. During cooking, the heat quantities are generally vaporization of water (approximately 35%), heat needed for sensible heating up to boiling temperature (approximately 20%) and convection and radiation losses from the system to surroundings (approximately 45%).

A typical box-type solar cooker is shown in **Fig.1.**

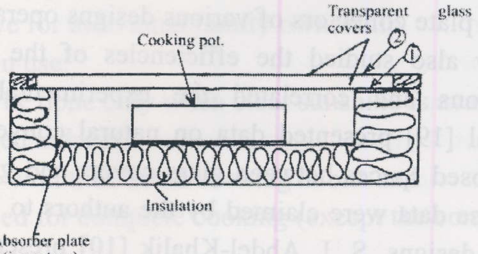

Figure 1: Schematic diagram of a box type solar cooker.

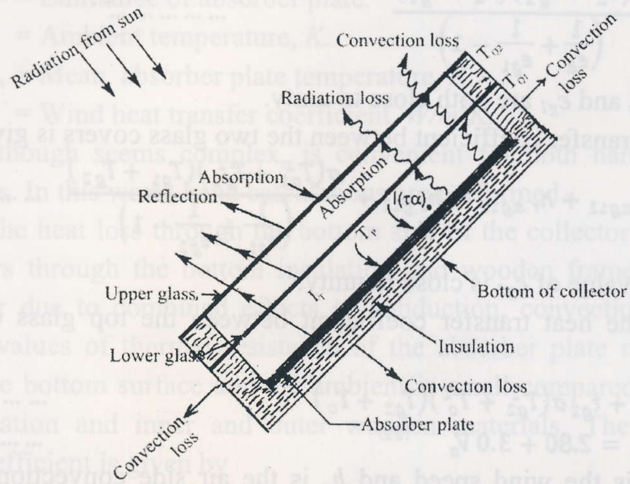

Figure 2: Heat transfer process in flat-plate solar collectors.

Accurate thermal analysis of the solar cooker is rather complex because of three-dimensional unsteady heat transfer processes. To determine performance parameters and to compare performances with other solar cookers, it is necessary to consider cooker parameters that are nearly independent of the climatic conditions such as solar radiation intensity and ambient temperature.

The different heat transfer items that occur in a solar collector are shown in **Fig.2**. Heat losses occur from all sides of the cooker. In well-insulated boxes, heat loss from the sides and the bottom are small. The heat loss from the top surface is most important and critically influences the thermal performance. This heat loss depends on the absorber plate temperature, the ambient temperature and the wind speed.

4 PERFORMANCE EQUATIONS

Heat transfer coefficient between the absorber plate and the inner glass cover is given by

$$U_{ag1} = h_{c,ag1} + \frac{\sigma(T_a^2 + T_{g1}^2)(T_a + T_{g1})}{\left(\frac{1}{\varepsilon_a} + \frac{1}{\varepsilon_{g1}} - 1\right)} \quad \ldots\ldots\ldots \quad (1)$$

$$= h_{c,ag1} + h_{r,ag1},$$

Where the radiation, heat transfer coefficient $h_{r,ag1}$ is given by

The indicated solar radiation is the sum of the useful energy, thermal losses and optical losses. Hence, under steady condition one can write

$$I_T A_a = Q_u + Q_{L0} + U_L A_a (t_{a,m} - t_0)$$

$$or.\, Q_u = I_T A_a - Q_{L0} - U_L A_a (t_{a,m} - t_0) \quad \ldots\ldots\ldots\ldots \quad (12)$$

$$or.\, q_u = \frac{Q_u}{A_a} = I_T - q_{L0} - U_L (t_{a,m} - t_0) \quad \ldots\ldots\ldots\ldots \quad (12a)$$

The cooker collector efficiency is then

$$\eta_{ic} = \frac{\text{useful energy over a period of time}}{\text{Energy incident over the same period}}$$

$$= \frac{\int_0^\tau Q_u d\tau}{\int_0^\tau I_T A_a d\tau} \quad \ldots\ldots\ldots\ldots \quad (13)$$

In **Eq.12**, I_T is the total solar radiation incident upon the collector and is equal to the sum of the direct and diffuse components. Ground reflected diffuse radiation is usually small and is neglected. Optical loss Q_{L0} is about 15% of the total radiation for common glasses [23].

5 CONSTRUCTION OF COOKER

The main components are:

(i) Outer wooden box.
(ii) Inner wooden box.
(iii) Glass-wool insulation between two boxes.
(iv) Two numbers glass cover plates.
(v) Three numbers booster plane reflecting mirrors and
(vi) A thin wooden cover on top to protect the cooker against dust, dirt, etc. when not in operation.

The outer and inner boxes are made of good quality locally available mango wood. The absorber plate is made of 18 *gauge* galvanized iron sheet and is painted matt-black for good absorption of the solar radiation. The sides of the inner box are also painted black for good absorption of solar radiation. Two transparent glass cover plates are properly fixed on the box. The booster mirrors are of standard type and hinge to the top three edges of the box with arrangements to hold the reflectors at desired angles for best reflection of the incident radiation.

Arrangement is also made to tilt and fix the cooker manually at an angle with the horizontal to track the sun for maximum solar radiation. Important data of the cooker are as follows:

Length	= 900 *mm*
Width	= 280 *mm*
Height	= 290 *mm*
Absorber plate thickness	= 1.21 *mm*, $k_a = 60\ W/mK$, $\rho_a = 7{,}880\ kg/m^3$
Glass wool insulation thickness	= 50 *mm*, $k_{gw} = 0.038\ W/mK$, $\rho_{gw} = 24\ kg/m^3$
Outer wooden box thickness	= 12 *mm*, $k_w = 0.05\text{-}1.0\ W/mK$, $\rho_w = 150\ kg/m^3$
Inner wooden box thickness	= 6 *mm*, $k_w = 0.05\text{-}1.0\ W/mK$, $\rho_w = 150\ kg/m^3$
Glass cover plates thickness	= 3 *mm*, $k_g = 0.78\ W/mK$, $\rho_g = 2700\ kg/m^3$
Space between two glass covers	= 25 *mm*
Emittance of glass cover plates	= 0.94
Emittance of absorber plate	= 0.95
Booster mirror sizes	= 940 *mm* x 300 *mm* (no.2), 320 *mm* x 300 *mm* (no.1)

A general view of the cooker is shown in **Fig.3**.

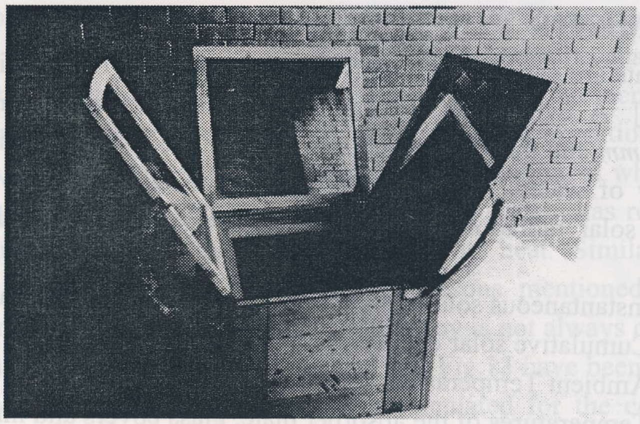

Figure 3: A view of the solar cooker.

Providing the booster reflectors increase the available solar radiation on the absorber plate. Therefore, it is expected that higher temperature will be reached in the cooker. This will result in reduction of the sensible heating time and hence the cooking time. It is clear that the reflector mirror on the right hand side (when the observer faces the cooker form the front) of the cooker will reflect most radiation after 12:00 noon (as the location is north latitude).

6 MEASUREMENTS

Temperatures on different locations of the cooker are measured by calibrated copper-constantan thermocouples of digital micro-voltmeter type, whereas the ambient temperatures are recorded by a mercury-in-glass thermometer. The hot junctions of the thermocouples are set and glue in well-cut grooves on the absorber plate and the glass covers. Temperatures are measured at five locations of the absorber plate and the average value is used in calculations of results. Two thermocouples are set at centers of the two glass cover plates. Four other thermocouples are set at centers of the inner surfaces of the four side of the cooker box. The instantaneous total solar radiation intensity falling on the glass covers (facing the sun) at the time of the experiments are continuously measured and recorded by a Kipp and Zonen solarimeter and data recorder. This data recorder also records the cumulative radiation energy over the period of the experiments. The average speeds of the air flowing over the cooker surfaces at that time of the experiment are recorded by a digital hand anemometer. Water temperatures in the cooking vessel are measured by a mercury-in-glass thermometer held rigidly at the centre of the vessel by supports.

7 EXPERIMENTS

Experiments are carried out over two weeks on sunny days during the month of April [26]. A cylindrical aluminum pot with inner diameter = 200 *mm*, height = 150 *mm* and thickness = 1.0 *mm* is used. The vessel is almost half-filled with 2.40 *kg* of water. The tilt angle can be varied into 50 to 15^0 for best reception of solar radiation. During the experiments, the following data are recorded:

(i) Instantaneous solar radiation intensity falling on the glass surface.
(ii) Cumulative solar energy every half an hour.
(iii) Ambient Temperature.
(iv) Temperatures of the absorber plate, glass covers and inner sides.
(v) Water temperature.
(vi) Ambient air velocity over the cooker box surface.

The above readings are recorded without and with the reflectors under identical conditions.

8 RESULTS AND CONCLUSIONS

Although experiments are carried out for about two weeks, results for four days, two in the first week of April and the other two in second week of April, are presented here. It should be noted that these results are representative of the other day's results. Results for these days are shown in **Fig.4** to **Fig.13**.

Fig.4 and **Fig.5** show that the absorber plate temperature is significantly increased when reflectors are used. The glass temperatures are also increased when reflectors are used which are shown in **Fig.6** and **Fig.8**. Clearly, more solar energy is put into the cooker chamber when reflectors are used. This also results in higher temperature of the water when reflectors are used which are shown in **Fig.7** and **Fig.9**. It is interesting to note that the maximum water temperature is about 65^oC without reflectors but it becomes 92^0C (close to cooking temperature of 100^0C) when reflectors are used. The overall heat loss coefficients are calculated using **Eq.7** and is found to increase with increase of the absorber temperature which is shown in **Fig.10** and **Fig.12**. This is expected because higher temperature of the absorber plate (which means higher temperature in the enclosed space) will cause higher heat loss from the cooker system to the surroundings. The largest heat loss coefficient is about 6.5 W/m^2K which is within the acceptable limit. The useful heat decreases as the absorber temperature increases which are shown in **Fig.11** and **Fig13**. This happens because at higher absorber temperatures the increase of heat loss is more than the increase of the solar radiation intensity. Moreover, during the early hours of operation, less heat loss occurs because part of the incident energy is used in heating of whole cooker system. When almost steady temperature of the cooker system has reached, the heat losses increase substantially reducing the useful heat. Similar trend is noticed for the cooker collector efficiency for reasons mentioned above. It should, however, be remembered that higher efficiency is not always desired, but higher useful energy is desired. Results in **Fig.10** to **Fig.13** have been calculated without reflectors. Such results have not been calculated for the cooker with reflectors because of complexity of evaluating the radiation energy gain by the reflectors. Calculations of U_L, Q_u and η_C with reflectors are recommended as further work.

It may be of interest to calculate the time needed for sensible heating of the water, say by 30^0C when the average value of Q_u=300 W/m^2. The heat required is (2.40)(4.2)(30)=302 kJ. The useful heat Q_u=(300)(3.60)(0.90)(0.28)=272 kJ/h. Then, the heating time τ = 302/272=1.11 *hour*. Experiments show that this time is about 2.0 *hours*.

It can be finally concluded that a box-type solar cooker with booster reflectors may produce cooking temperature (100^0C) if the cooker is properly designed, carefully constructed, and operated even in a moderate climatic country like Bangladesh.

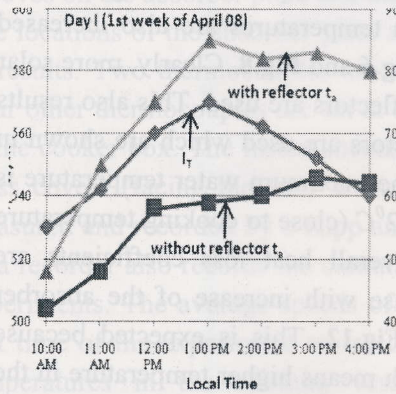

Figure 4: $t_o = 33^0C$, Average Wind Speed = 1.5 *m/s*.

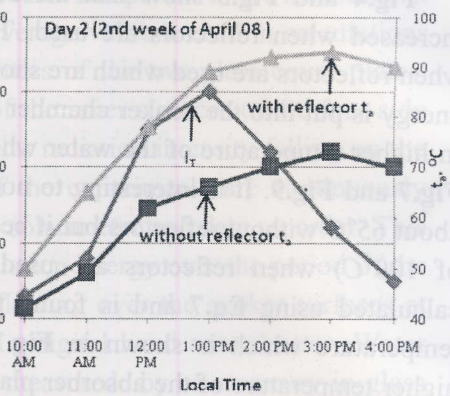

Figure 5: $t_o = 36^0C$, Average Wind Speed = 1.0 *m/s*.

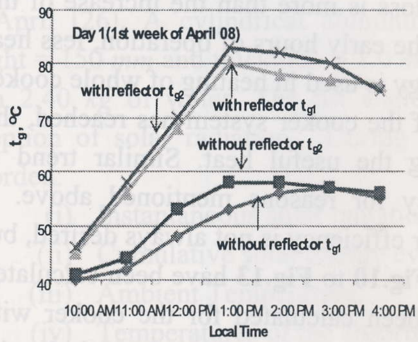

Figure 6: $t_o = 33^0C$, Average Wind Speed = 1.5 *m/s*.

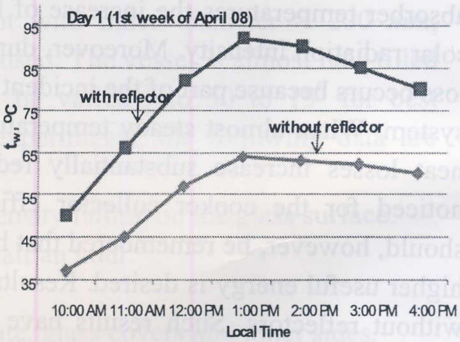

Figure 7: $t_o = 33^0C$, Average Wind Speed = 1.5 *m/s*.

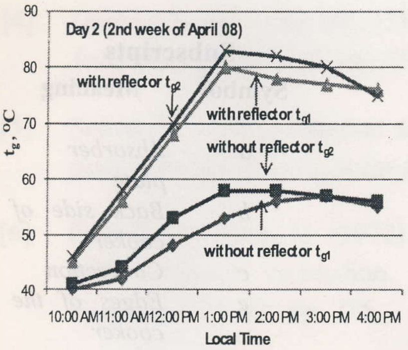

Figure 8: $t_o = 36^0C$, Average Wind Speed = 1.0 m/s.

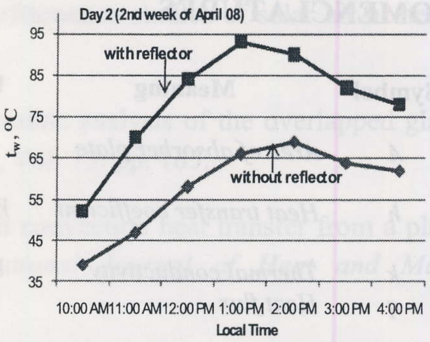

Figure 9: $t_o = 36^0C$, Average Wind Speed = 1.0 m/s.

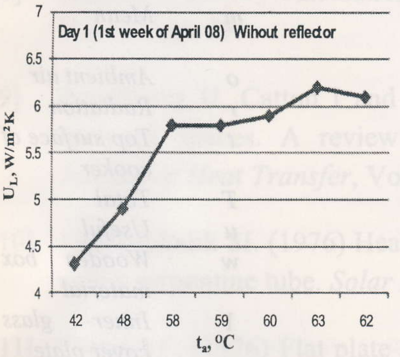

Figure 10: $t_o = 33^0C$, Average Wind Speed = 1.5 m/s.

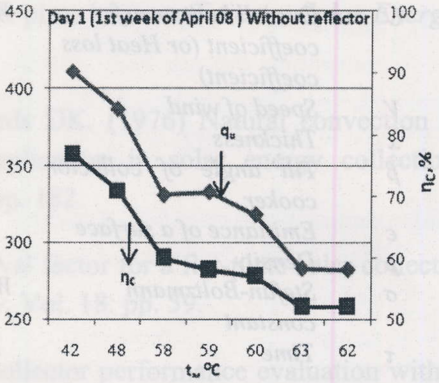

Figure 11: $t_o = 33^0C$, Average Wind Speed = 1.5 m/s.

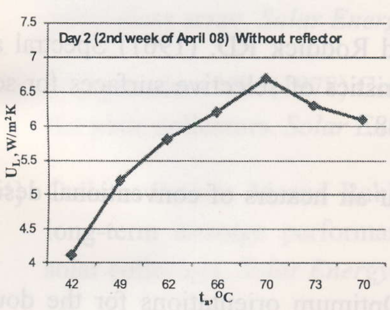

Figure 12: $t_o = 36^0C$, Average Wind Speed = 1.0 m/s.

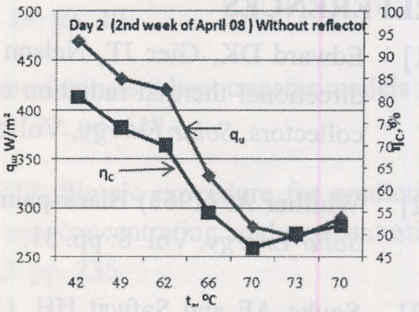

Figure 13: $t_o = 36^0C$, Average Wind Speed = 1.0 m/s.

NOMENCLATURES

Symbol	Meaning	Units	Subscripts Symbol	Subscripts Meaning
A	*Area of absorber plate*	m^2	a	*Absorber plate*
h	*Heat transfer coefficient*	W/m^2K	b	*Back side of cooker*
k	*Thermal conductivity*	W/mK	c	*Convection*
q	*Heat flux*	W/m^2	e	*Edges of the cooker*
Q	*Heat Transfer rate*	W	g	*Glass cover plates*
t	*Temperature*	^0C	i	*Insulation material*
T	*Absolute temperature*	K	L	*Losses*
U	*Overall heat transfer coefficient (or Heat loss coefficient)*	W/m^2K	m	*Mean*
V	*Speed of wind*	m/s	o	*Ambient air*
x	*Thickness*	m	r	*Radiation*
β	*Tilt angle of collector cooker*	m	t	*Top surface of cooker*
ϵ	*Emittance of a surface*	-	T	*Total*
ρ	*Density*	kg/m^3	u	*Useful*
σ	*Stefan-Boltzmann constant*	W/m^2K^4	w	*Wooden box material*
τ	*Time*	h or s	1	*Inner glass cover plate*
η_C	*Cooker collector efficiency*	%	2	*Outer glass cover plate*

REFERENCES

[1] Edward DK, Gier JT, Nelson EE and Roddick RD. (1961) Spectral and directional thermal radiation characteristics of selective surfaces for solar collectors. *Solar Energy*, Vol. 5: pp. 48.

[2] Whillier A. (1963) Black-painted solar air heaters of conventional design. *Solar Energy*, Vol. 8: pp. 31.

[3] Souka AF and Safwat HH. (1966) Optimum orientations for the double exposure flat plate collector and its reflectors. *Solar Energy*, Vol. 10: pp. 170.

[4] Gupta CL and Garg HP. (1967) Performance studies of solar air heaters., *Solar Energy*, Vol. 11, pp. 25.

[5] Selcuk K. (1971) Thermal and economic analysis of the overlapped glass plate solar air heaters. *Solar Energy*, Vol. 13: pp. 165.

[6] Fujii T and Imura H. (1972) Natural convection heat transfer from a plate with arbitrary inclination. *International Journal of Heat and Mass Transfer*, Vol. 15: pp. 775.

[7] Klein SA, Duffie JA and Beckman WA. (1974) Transient considerations of flat plate solar collectors. *Transactions ASME, Journal of Engineering for Power*, pp. 109.

[8] Klein SA. (1975) Calculation of flat-plate loss coefficients. *Solar Energy*, Vol. 17: pp. 79.

[9] Bouchberg H, Catton I and Edwards DK. (1976) Natural convection in enclosed spaces. A review of application in solar energy collection. *Journal of Heat Transfer*, Vol. 98: pp. 182.

[10] Abdel-Khalik SI. (1976) Heat removal factor for a flat-plate solar collector with a serpentine tube. *Solar Energy*, Vol. 18: pp. 59.

[11] Simon FF. (1976) Flat plate solar collector performance evaluation with a solar simulation as a basis for collector selection and performance prediction. *Solar Energy*, Vol. 18: pp. 451.

[12] Edwards DK. (1977) Solar absorption by each element in an absorber cover glass array. *Solar Energy*, Vol. 19: pp. 401.

[13] Wijeysundera NE. (1978) Comparison of transient heat transfer models for flat plate collectors. *Solar Energy*, Vol. 21: pp. 517.

[14] Collares-Pereira M and Rabl A. (1979) Simple procedure for predicting long-term average performance of non-concentrating and concentrating solar collectors. *Solar Energy*, Vol. 23: pp. 235.

[15] Klein SA and Beckman WA. (1979) A general design method for closed-loop solar energy systems. *Solar Energy*, Vol. 22: pp. 269.

[16] Brandemuehl MJ and Beckman WA. (1980) Transmisson of diffuse radiation through CPC and flat-plate collector glazing. *Solar Energy*, Vol. 24: pp. 511.

[17] Malhotra A, Garg HP and Palit A. (1981) Heat loss calculations of flat plate solar collectors. *Journal of Thermal Energy*, Vol. 2.

[18] Saxena AK, Kandpal TC and Mullick SC. (1984) Evaluation of box-type solar cookers. *Proceedings of National Solar Convention*, Bhopal, India.

[19] Mullick SC, Kandpal TC and Saxena AK. (1987) Thermal test procedure for box-type solar cookers. *Solar Energy*, Vol. 39, pp. 353.

[20] Mullick SC and Samdarshi SK. (1988) An improved technique for computing the top heat loss factor of a flat plate collector with a single glazing. *Transaction of the ASME, Journal of Solar Energy Engineering*, Vol. 110, pp. 262.

[21] Kumar S, Sharma VB, Kandpal TC and Mullick SC. (1997) Wind induced heat losses from outer cover of solar collectors. *Renewable Energy*, Vol. 10, pp. 613.

[22] Mullick SC, Kandpal TC and Kumar S. (1997) Correlations for top heat loss factor of double-glazed box-type solar cooker from indoor experiments. *Renewable Energy*, Vol. 22, pp. 559.

[23] Watmuff JH, Charters WWS and Proctor D. (1977) Solar and wind induced external coefficients for solar collectors. Comples 2.

[24] Holman JP. (1990) Heat Transfer. *McGrow-Hill Book Company*, 7th Ed.

[25] John A Duffie and Beckman WA. (1997) Solar Engineering of Thermal Processes. *2nd Ed. John-Wiley Songs.*

[26] B.Sc. Engineering final year project, IUT. (2008) The performance test of a solar cooker.

(Contd. from 2nd cover page)

8. SI units must be used in the manuscript. However, other units may be used in parenthesis.

9. Tables should be referred to in consecutive Arabic numerical. Each table must have a table caption.

10. Line drawings must be in a form suitable for reproduction e.g., laser printout, drawn in Indian ink on white paper or on tracing paper. Photographs should have a glossy finish. Each figure must have a number and a figure caption. Elecrtonic mode is preferred.

11. References should be set out in alphabetical order of the author's last name in a list at the end of the article. They should be given in standard form as in the following examples :

(a) Journal
   Bloomer G and Wright A. (1984) Scheduling of Vehicles from Factory to Depot. *Journal of Vehicles*, Vol. 12: pp. 590-598.

(b) Book
   Best, John., and Kahn, James V., Research in Education, Prentice-Hall, New Jersey, 1986.

(c) Monograph
   Syedali, M.M. "Computer Controlled Car", Thesis, M.Sc. Engineering, Department of Mechanical Engineering, BUET, 1990

(d) Conference Paper
   Hasan M and Ullah MS. "Tourism development in the Chittagong Hill Tracts of Bangladesh after the peace agreement of 1997", a paper submitted to the Regional Conference on physical mobility and development in the mountains", Tribhuvan University, 15-17, March, 2000 Kathmandu, Nepal, pp.12

(e) Unpublished paper
   Ahmadi, R and Tangs : Production Allocation with Dual Provisioning, Working Paper, Anderson Graduate School of Management, UCLA (1991)

12. The University does not accept responsibility for loss or damage of manuscript while in mail.

13. The responsibility for opinions in the contributions rests entirely on their authors.

14. The author (s) must submit declaration that the paper was not published elsewhere.

15. In case of joint papers, communication will be made with the first author.

16. The University will reserve the copyright of the paper once it is accepted for publication in the Journal. The authors must obtain written parmission from REASP, IUT for publication elsewhere.

Procedure for acceptance of papers and publications :

1. Papers submitted for publication will be referred to the listed reviewers for assessment. However, the editorial board will make initial screening of the papers.

2. After the assessment, the authors may be requested to modify/clarify certain points.

3. Accepted/modifed/corrected papers will be published in the next issue of the Journal.